

課題番号 : F-15-HK-0065
利用形態 : 共同研究
利用課題名(日本語) :
Program Title(English) : Carrier-Envelope Phase Control of Plasmonic Nanostructures using ToF-PEEM
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1. 概要(Summary)

The recent vast progress in the development of few-cycle optical has enabled new types of ultrafast experiments such as carrier-envelope phase (CEP) sensitive measurements aiming to steer electron motion on ultrashort time scales and nanometer spatial resolutions. In this study, a time of flight-photoemission electron microscope (ToF-PEEM) is combined with a single-shot stereographic above-threshold ionization phase meter for studying attosecond control of electrons in tailored plasmonic nanostructures spatially and energetically via a CEP tagging technique.

2. 実験(Experimental)

【利用した主な装置】

Electron beam lithography (EBL) system, Helicon Sputter System, Field Emission Scanning Electron Microscope.

【実験方法】

We performed the CEP-tagged PEEM experiment on gold triangles via a multiphoton photoemission process excited by 5-fs laser pulses. The sample (gold triangles on a tin-doped indium oxide coated glass substrate) was fabricated in the group of Prof. Hiroaki Misawa from Hokkaido University, Japan using EBL technique. A laser peak intensity in the order of $\sim 10^9$ W/cm² was used for sample illumination. The incoming laser was 65° to the sample surface normal and the polarization of the laser was parallel to the triangle axis.

3. 結果と考察(Results and Discussion)

Figure 1a shows the UV-PEEM image of the arrays of gold triangle nanostructures of angle 33° starting

from the smallest axis length of 90 nm with an increasing step length of 20 nm from the bottom to the top of the PEEM image. Figure 1b depicts the energy-integrated PEEM image of the same arrays of gold triangle as shown in a. In order to analyze the CEP dependence, the difference between CEP-resolved electron spectra and the CEP-averaged electron spectrum, normalized to the peak amplitude of the CEP-averaged spectrum, is taken to enhance the CEP effect and depict the modulation depth. It is shown as a CEP spectrogram in Figure 1c. A very weak CEP modulation of pi periodicity is visible at the correct tag offset. It is believed that this pi modulation is contributed by the intensity-related CEP artifact rather than a true CEP effect. The detailed analysis of the data is still in process.

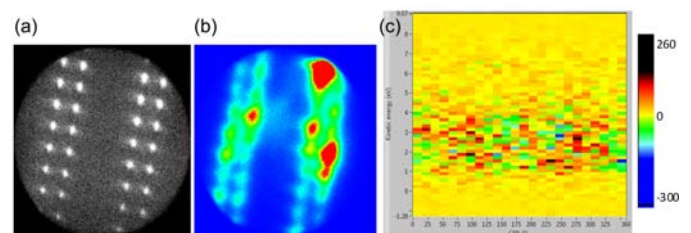


Fig. 1 (a) PEEM image of the triangle arrays excited by a UV lamp. Field of view = 4.5 μ m. (b) PEEM image of the same area as shown in a, acquired with fs-laser pulses. The hot spots are originated from plasmonic-enhanced photoemission from the triangle tips. (c) Normalized CEP spectrogram for the gold triangles with the averaged spectrum subtracted. The colorbar represents the counts.

4. その他・特記事項(Others)

Collaborator: (RIES, Hokkaido Univ.) Quan Sun, Han Yu, Kosei Ueno, Hiroaki Misawa

5. 論文・学会発表(Publication/Presentation)

N/A

6. 関連特許(Patent)

N/A